CS209A Project Report

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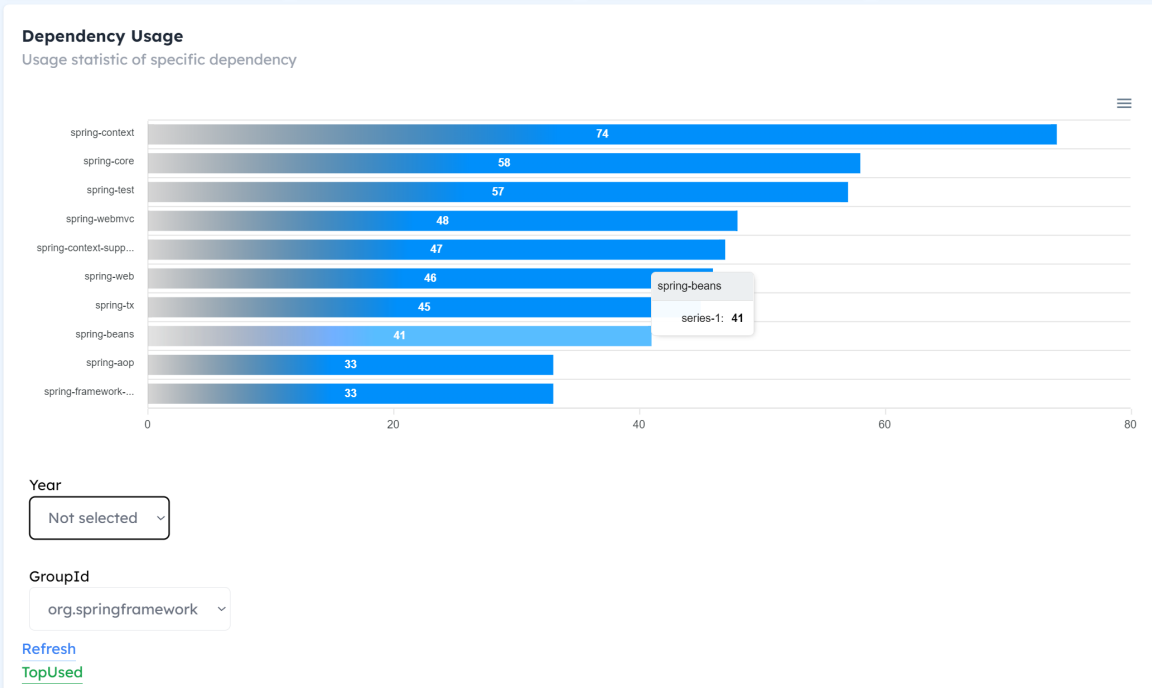
Overview

In this project, we mainly discuss two major issues:

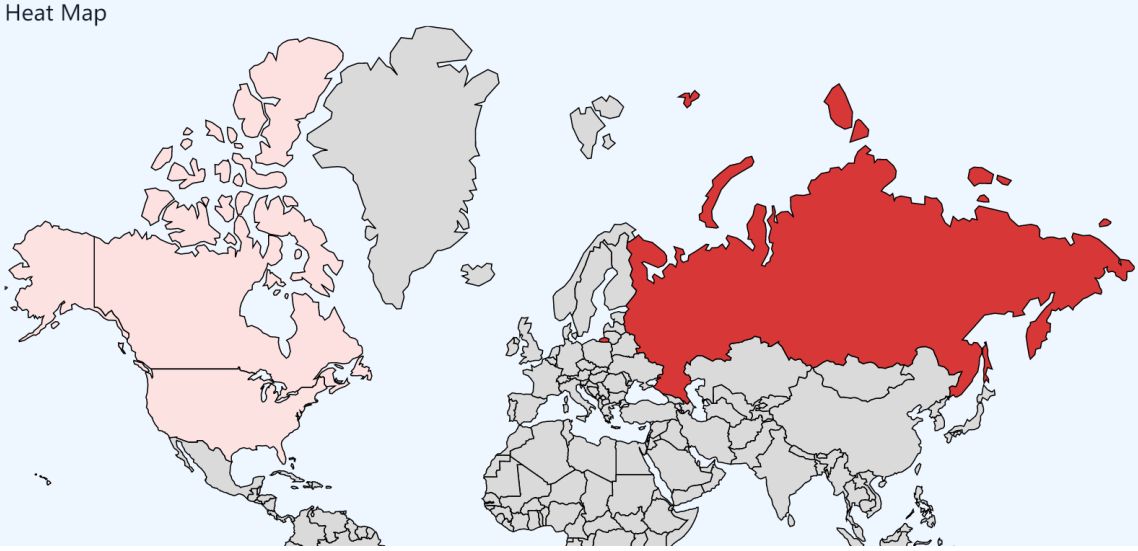
- Hot dependencies in pom.xml



- Tool used contribution in different countries

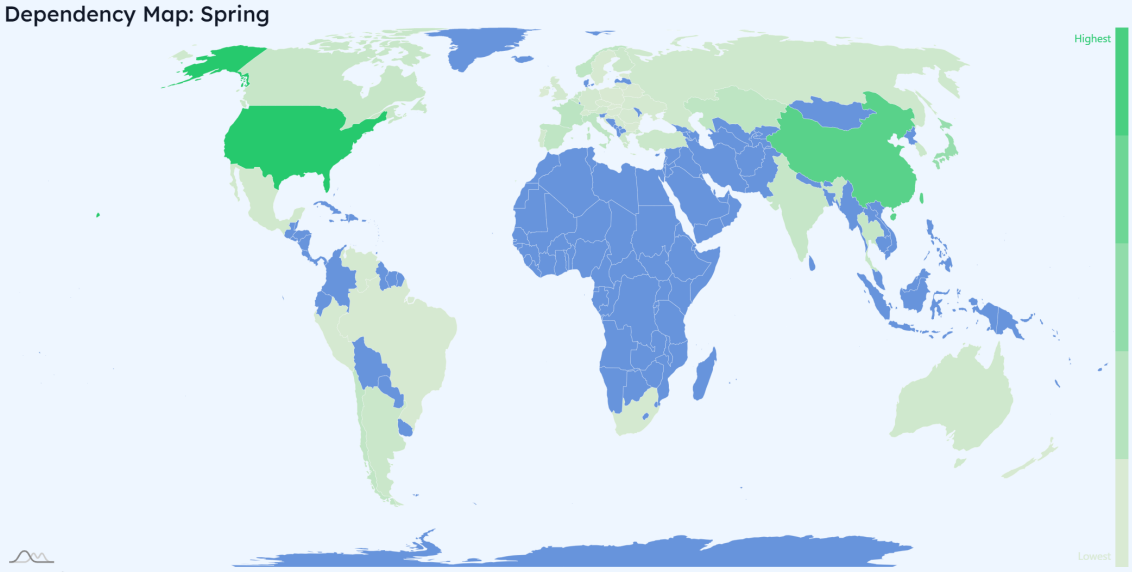
Dependency Analysis

Heat Map



DependencyMap

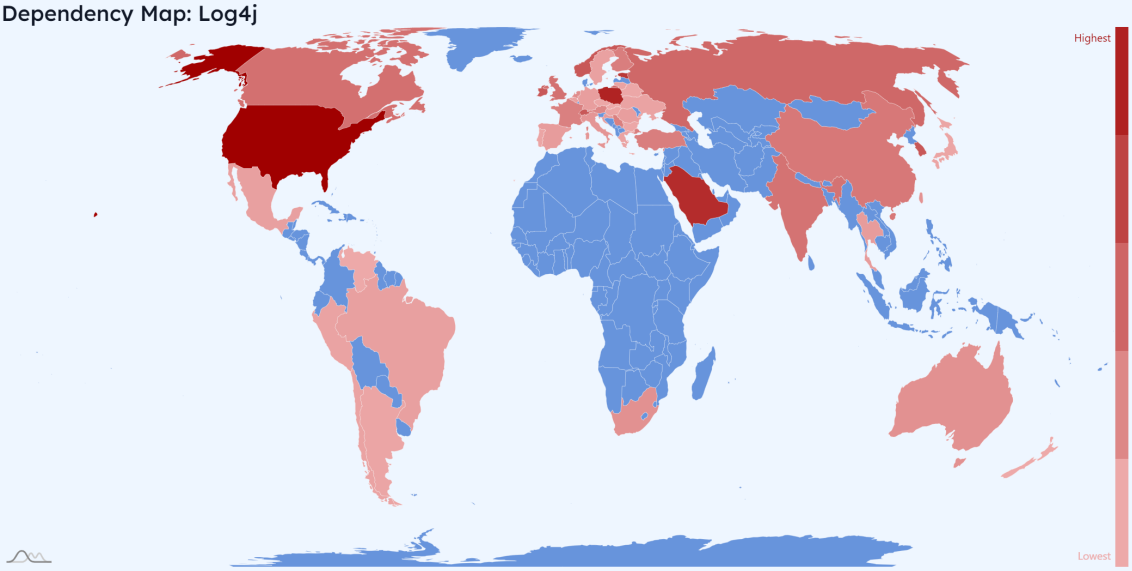
Dependency Map: Spring



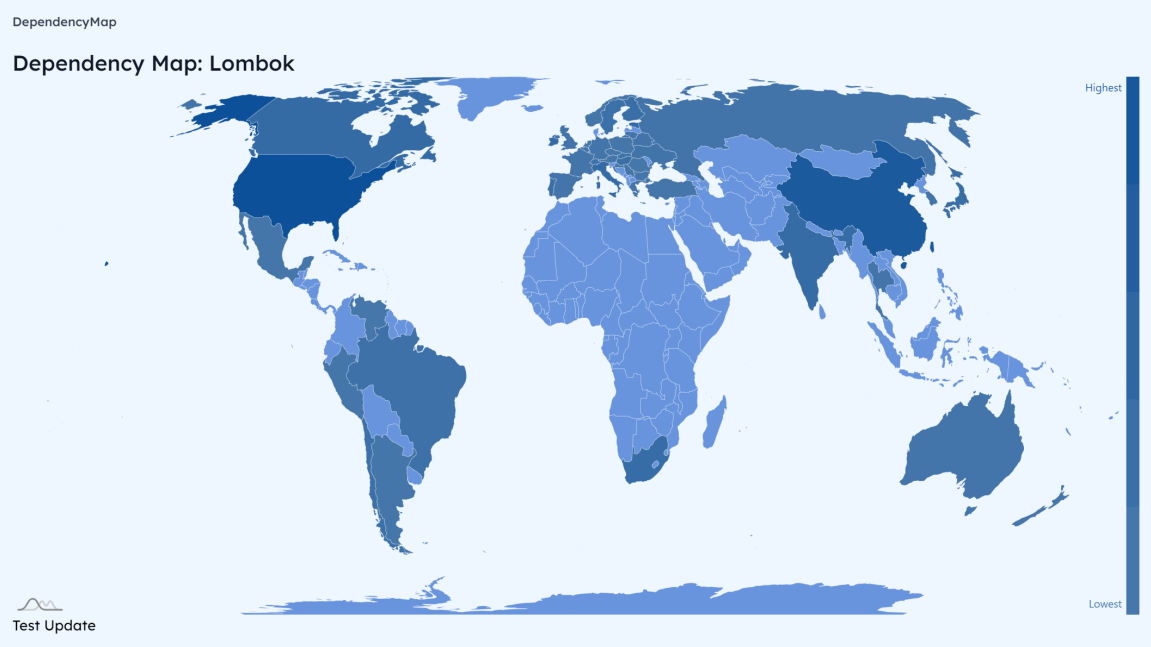
Test Update

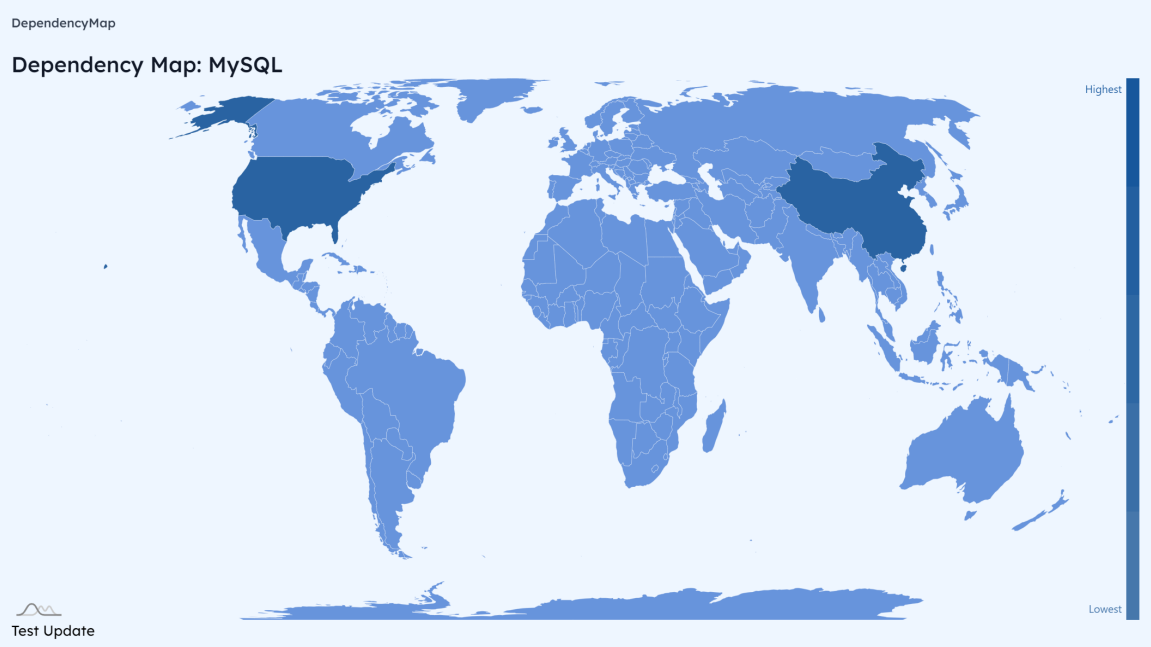
DependencyMap

Dependency Map: Log4j



Test Update





The architecture of the project is **Vue + SpringBoot**. The development of frontend and backend are splited, and as a result any of them can work separately. The interaction between the frontend and the backend are achieved through Rest API, and we use **Json** as the data exchange format.

In this report, we will introduce the features related to the evaluation and the structure of this project.

Features

Project Structure

Frontend

File tree

```
|   .browserslistrc
|   .gitignore
|   babel.config.js
|   jsconfig.json
|   LICENSE
|   package-lock.json
|   package.json
|   postcss.config.js
|   preview.png
|   README.md
|   tailwind.config.js
|   vue.config.js
|   yarn.lock
|
├───public
|       .htaccess
|       favicon.ico
|       index.html
|       web.config
|       _redirects
|
└───src
    |   App.vue
    |   main.js
    |
    ├───assets
    |   |   animate.css
    |   |   logo.png
    |   |   tailwind.css
    |   |
    |   ├───img
    |   |       user.jpg
    |   |       user.png
    |   |       user1.png
    |   |       user2.png
```

```
|   |       user3.png
|   |       user4.png
|   |       user5.png
|   |
|   └──sass
|       |   app.windzo.scss
|       |
|       └──css
|               windzo.css
|               windzo.css.map
|
├──components
|       AppAccordion.vue
|       Dropdown.vue
|       Footer.vue
|       Header.vue
|       MenuAccordion.vue
|       Sidebar.vue
|
├──router
|       index.js
|
└──views
    |   Dashboard.vue
    |
    └──components
            accordion.vue
            alert.vue
            badges.vue
            breadcumbs.vue
            button.vue
            card.vue
```

Structure

The whole frontend is based on `NodeJs` and `Vue.js` framework. The intention is to create a dynamic web application that allows user interaction from **web brosers** for an immersive user experience, and without the need to interact with the server API to change the web content. *In this project we used Windzo as a template* (See sahrullahh/windzo: Free Open Source Template Dashboard Admin Vue Tailwind CSS (github.com)).

The frontend and the backend uses **Rest API** to communicate: The frontend uses `get` method to get the data from the backend server. When necessary, it also uses `post` method to post configurations and operations to the backend server for further actions.

```
Navigation
├——DashBoard
├——ComponentTest
|       ├——Accordion
|       ├——Alert
|       ├——Badges
|       ├——Breadcumbs
|       ├——Button
|       ├——Card
|       └——Badges
└——OnlineTest
```

DashBoard

In this views, we implement two main scenes.

World Map

In this scene, we can choose some groupIds by some buttons, then the world map will display the number of the dependency,

which is ordered by country and each country will generate a color based on the number of dependencies. (The color will be changed by the groupId.)

![image-20220524232908001](C:\Users\Administrator\AppData\Roaming\Typora\typora-user-images\image-20220524232908001.png

Besides, we add some events in the map ,when the mouse passby some countries, it will display the amount of the dependencies of the country.

Barchart

Backend

File tree

```
├──java
|   └──edu
|       └──sustech
|           ├──backend
|           |   ├──controller
|           |   |   └──API
|           |   ├──dao
|           |   ├──dto
|           |   ├──entities
|           |   └──service
|           |       └──models
|           └──search
|               └──engine
|                   └──github
|                       ├──analyzer
|                       ├──API
|                       |   ├──rate
|                       |   └──search
|                       |       └──requests
|                       ├──models
|                       |   ├──code
|                       |   ├──commit
|                       |   ├──content
|                       |   ├──githubapp
|                       |   ├──issue
|                       |   ├──label
|                       |   ├──pullrequests
|                       |   ├──repository
|                       |   ├──topic
|                       |   └──user
|                       ├──parser
|                       └──transformer
└──resources
    └──dao
```

Dependency Usage

In this part, we can statics the top used dependency.

In order to improve the user's experience, we also provide two tables for filtering. See the figure in the headers.

Controller

getTopUsedDependencies

```
@RequestMapping("data/top-used-dependencies")
public ResponseEntity<String> getTopUsedDependencies(
    @RequestParam(value = "group", required = false) String group,
    @RequestParam(value = "date", required = false) Date date,
    @RequestParam(value = "count", required = false, defaultValue =
"10") Integer count) {
    return
ResponseEntity.ok(backendService.getTopUsedDependencies(group,
date, count));
}
```

This method returns the top used dependencies using specific param: **group、date、count**

The frontend can also set no search param to get the general result

getTopUsedVersions

```
@RequestMapping("data/top-used-version")
public ResponseEntity<String> getTopUsedVersions(
    @RequestParam("group") String group,
    @RequestParam("arifact") String artifact,
    @RequestParam(value = "year", required = false) Integer year) {
    return
ResponseEntity.ok(backendService.getTopUsedVersions(group,
artifact, year));
}
```

This method returns the top used versions of specific **group**'s **artifact** in a specific **year(not neccessary)** to frontend

getGroups

```
@RequestMapping("groups")
public String getGroups(){
    return backendService.getAvailableGroupSelections();
}
```

This method returns the group list that the user can select

update

```
@RequestMapping("local/update-all")
public ResponseEntity<String> update() throws IOException,
InterruptedException {
    if (status == UpdateStatus.NOT_INITIATED) {
        status = UpdateStatus.PROGRESS;
        updateData();
    } else {return ResponseEntity.badRequest().body("Failed. The
update is initiated: " + status);}
    return ResponseEntity.ok("OK. Update status: " + status);
}
```

This method updates all the data for frontend by invoking the GitHub Search Engine.

GitHub Search Engine

To make the searching process more fluently, automatically and more robust, we introduce the GitHub Search Engine.

This GitHub Search Engine has iterated *several* times, been published to GitHub and has till now released several packages of different versions. You can check them on IskXCr/GitHubSearchEngine: A GitHub search engine for backend application. To load the GitHub Search Engine from GitHub Packages, you may need to configure your local `.m2` maven repository settings (which is typically under the `Users/{UserName}` folder, if Windows is considered).

File Tree

```
edu.sustech
└──engine
    ├──github
    |   ├──analyzer
    |   |       Analyzer.java
    |   |
    |   ├──API
    |   |   |   ContentAPI.java
    |   |   |   FileAPI.java
    |   |   |   GitHubAPI.java
    |   |   |   RepositoryAPI.java
    |   |   |   RequestRateExceededException.java
    |   |   |   RestAPI.java
    |   |   |   SearchAPI.java
    |   |   |   UserAPI.java
    |   |   |
    |   |   ├──rate
    |   |   |       ActionsRunnerRegistration.java
    |   |   |       CodeScanningUpload.java
    |   |   |       Core.java
    |   |   |       Graphql.java
    |   |   |       IntegrationManifest.java
```

```
    |   |   |       Rate.java
    |   |   |       RateLimitResult.java
    |   |   |       Resources.java
    |   |   |       Scim.java
    |   |   |       Search.java
    |   |   |       SourceImport.java
    |   |   |
    |   |   ├──repository
    |   |   ├──search
    |   |   |   |   ETag.java
    |   |   |   |   InvalidResultException.java
    |   |   |   |
    |   |   |   └──requests
    |   |   |           CodeSearchRequest.java
    |   |   |           CommitSearchRequest.java
    |   |   |           IPRSearchRequest.java
    |   |   |           LabelSearchRequest.java
    |   |   |           RepoSearchRequest.java
    |   |   |           SearchRequest.java
    |   |   |           TopicSearchRequest.java
    |   |   |           UserSearchRequest.java
    |   |   |
    |   |   └──user
    |   ├──models
    |   |   |   Alias.java
    |   |   |   APIErrorMessage.java
    |   |   |   AppendableResult.java
    |   |   |   Author.java
    |   |   |   AuthorAssociation.java
    |   |   |   CodeOfConduct.java
    |   |   |   Dependency.java
    |   |   |   Entry.java
    |   |   |   License.java
    |   |   |   Match.java
    |   |   |   Milestone.java
    |   |   |   OAuthToken.java
    |   |   |   Owner.java
    |   |   |   Parent.java
    |   |   |   Permissions.java
    |   |   |   Reactions.java
    |   |   |   Related.java
    |   |   |   State.java
```

```
|   |   |   TextMatch.java
|   |   |
|   |   ├──code
|   |   |       CodeItem.java
|   |   |       CodeResult.java
|   |   |
|   |   ├──commit
|   |   |       Commit.java
|   |   |       CommitItem.java
|   |   |       CommitResult.java
|   |   |       Tree.java
|   |   |       Verification.java
|   |   |
|   |   ├──content
|   |   |       ContentDirectory.java
|   |   |       ContentFile.java
|   |   |       Links.java
|   |   |       RawContent.java
|   |   |       SymlinkContent.java
|   |   |
|   |   ├──filetree
|   |   ├──githubapp
|   |   |       GitHubApp.java
|   |   |       Permissions.java
|   |   |
|   |   ├──issue
|   |   |       IPRResult.java
|   |   |       Issue.java
|   |   |
|   |   ├──label
|   |   |       Label.java
|   |   |       LabelResult.java
|   |   |
|   |   ├──pullrequests
|   |   |       PullRequest.java
|   |   |       PullRequestResult.java
|   |   |
|   |   ├──repository
|   |   |       Repository.java
|   |   |       RepositoryResult.java
|   |   |
|   |   ├──topic
```

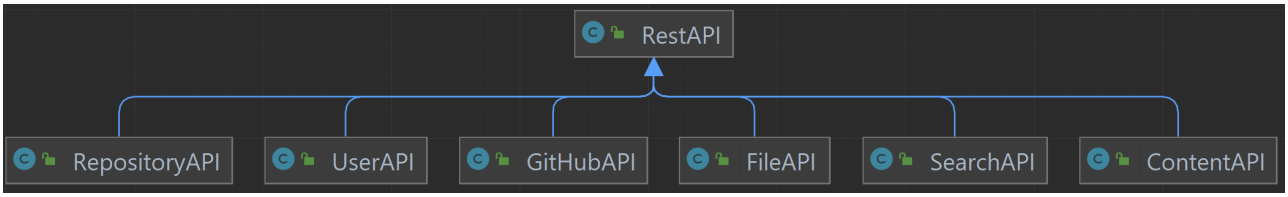
```
    |   |   |       Topic.java
    |   |   |       TopicRelation.java
    |   |   |       TopicResult.java
    |   |   |
    |   |   └──user
    |   |           User.java
    |   |           UserResult.java
    |   |
    |   ├──parser
    |   |       JsonSchemaParser.java
    |   |
    |   ├──test
    |   └──transformer
    |           Transformer.java
    |
    └──stackoverflow
```

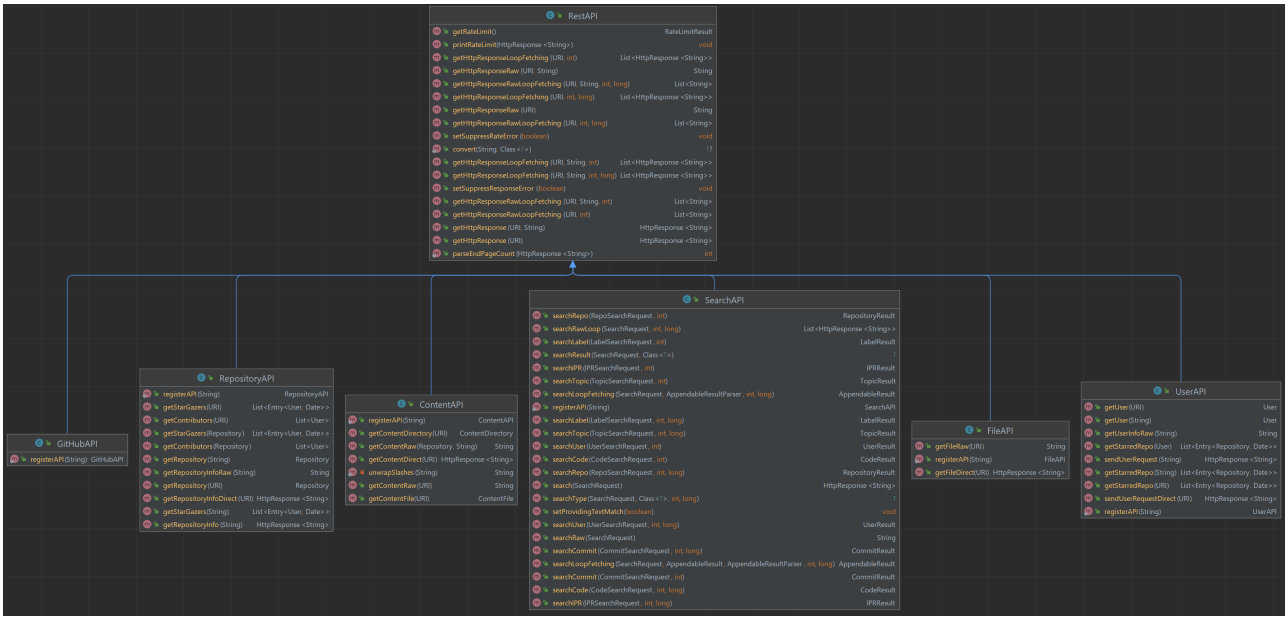
Functionality & Features

The engine has a ***full implementation (except for acquiring Trees)*** of the search function of the GitHub Rest API (`SearchAPI`) and provides ***Java abstractions*** for dealing with entities present in GitHub (for example, `Repository`, `User`, `Issues`, `Commits`, etc. Those existing models can be found inside the `models` directory in the source code). It also provides additional ***partially implemented*** APIs such as `UserAPI`, `RepositoryAPI` and `RateAPI` for other needs such as tracing user locations and attain the information related to real-time GitHub rate limits, get the contributions of an user to a specific repository, etc.

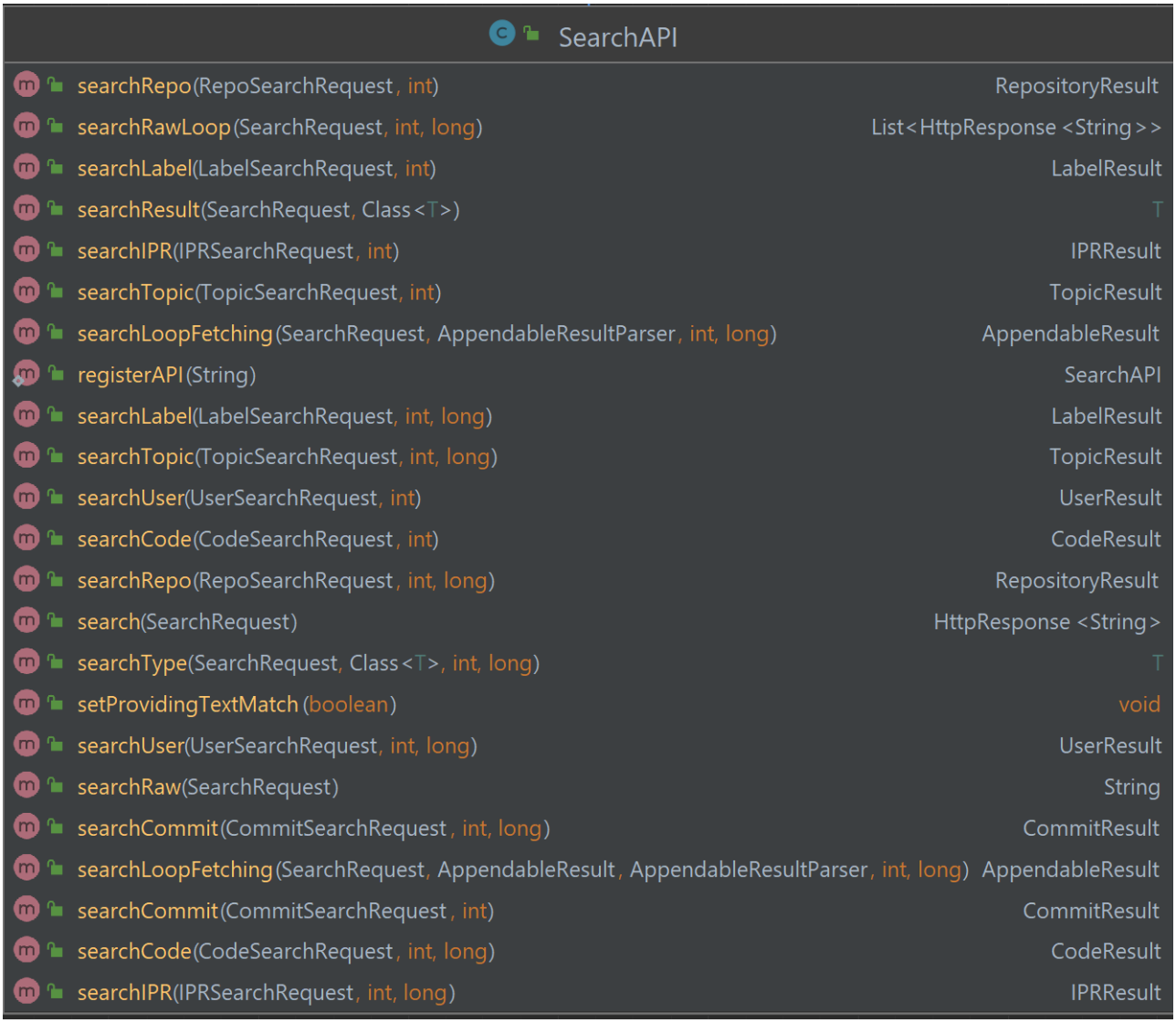
Search requests and along with other operations can be constructed through ***pure Java codes*** and be passed to the `SearchAPI` or `RepositoryAPI`, etc. In the implementation of the `SearchAPI`, all http responses received and the process of parsing , error/exception processing and loop fetching (fetch until results acquired are more than or equals to the desired number of results, which is a parameter that can be either specified or left to `Integer.MAX_VALUE`) are ***hidden at default*** from the caller. The user of this engine is able to manipulate the interaction with the GitHub SearchEngine (***without*** even learning the GitHub RestAPI) in a Java way and does not need to care about the inner processing and handling. Advanced manipulations of the engine can also be done with specified request parameters and through the usage of the generic methods pre-implemented.

All APIs are extended from the basic class `RestAPI`. `RestAPI` provides the basic functionality to communicate with the GitHub RestAPI, retrieving data from it, and parse the result into a required object.






RestAPI
getRateLimit() RateLimitResult
printRateLimit(HttpResponse <String>) void
getHttpResponseLoopFetching (URI, int) List<HttpResponse <String>>
getHttpResponseRaw (URI, String) String
getHttpResponseRawLoopFetching (URI, String, int, long) List<String>
getHttpResponseLoopFetching (URI, int, long) List<HttpResponse <String>>
getHttpResponseRaw (URI) String
getHttpResponseRawLoopFetching (URI, int, long) List<String>
setSuppressRateError(boolean) void
convert(String, Class<T>) T?
getHttpResponseLoopFetching (URI, String, int) List<HttpResponse <String>>
getHttpResponseLoopFetching (URI, String, int, long) List<HttpResponse <String>>
setSuppressResponseError(boolean) void
getHttpResponseRawLoopFetching (URI, String, int) List<String>
getHttpResponseRawLoopFetching (URI, int) List<String>
getHttpResponse (URI, String) HttpResponse <String>
getHttpResponse (URI) HttpResponse <String>
parseEndPageCount(HttpResponse <String>) int



Major Implementations in the `SearchAPI`

searchLoopFetching method

```
public AppendableResult searchLoopFetching(SearchRequest request1,
                                           @Nullable
AppendableResult origin
                                           AppendableResultParser
p,
                                           int count,
                                           long timeIntervalMillis)
throws InterruptedException, IOException {...}
```

This method uses `AppendableResult` as both one of the parameters and the result. The `AppendableResultParser` is an `@FunctionalInterface`, allowing the parsing and the manipulation of the object with unknown type.

searchLoopFetching method (Generic)

This method needs the target class to implement `AppendableResult` interface for combining result data from different responses.

```
/**
     * This method uses while loop to request for search results.
     * Please notice that the GitHub REST API may severely restrict
your ability to query the result.
     * <br>
     * If too often the secondary rate limit is encountered, please
increase the <code>timeIntervalMillis</code>
     * (a typical recommendation might be <code>18000</code>), and
run this method in another thread.
     *
     * @param <T>                Result type
     * @param request1           Request (will create another copy)
     * @param targetClazz        Target class for object mapper
     * @param count              Target Item count. Note that the
actual items retrieved might be more
     * @param timeIntervalMillis Preferred time interval between
requests
     * @return CodeResult
     * @throws IOException
     * @throws InterruptedException
     */
    @SuppressWarnings("unchecked")
    public <T extends AppendableResult> T searchType(SearchRequest
request1,
                                                     Class<T>
targetClazz,
                                                     int count,
                                                     long
timeIntervalMillis) throws IOException, InterruptedException {
        return (T) searchLoopFetching(request1,
                                      s -> convert(s, targetClazz),
                                      count,
```

```
                                            timeIntervalMillis); //It
must be T, so no worry.
    }
```

An automatical loop for dealing with the common exceptions, including `timeout`, `RateLimitExceeded` has been constructed to improve the user experience when in autonomous mode.

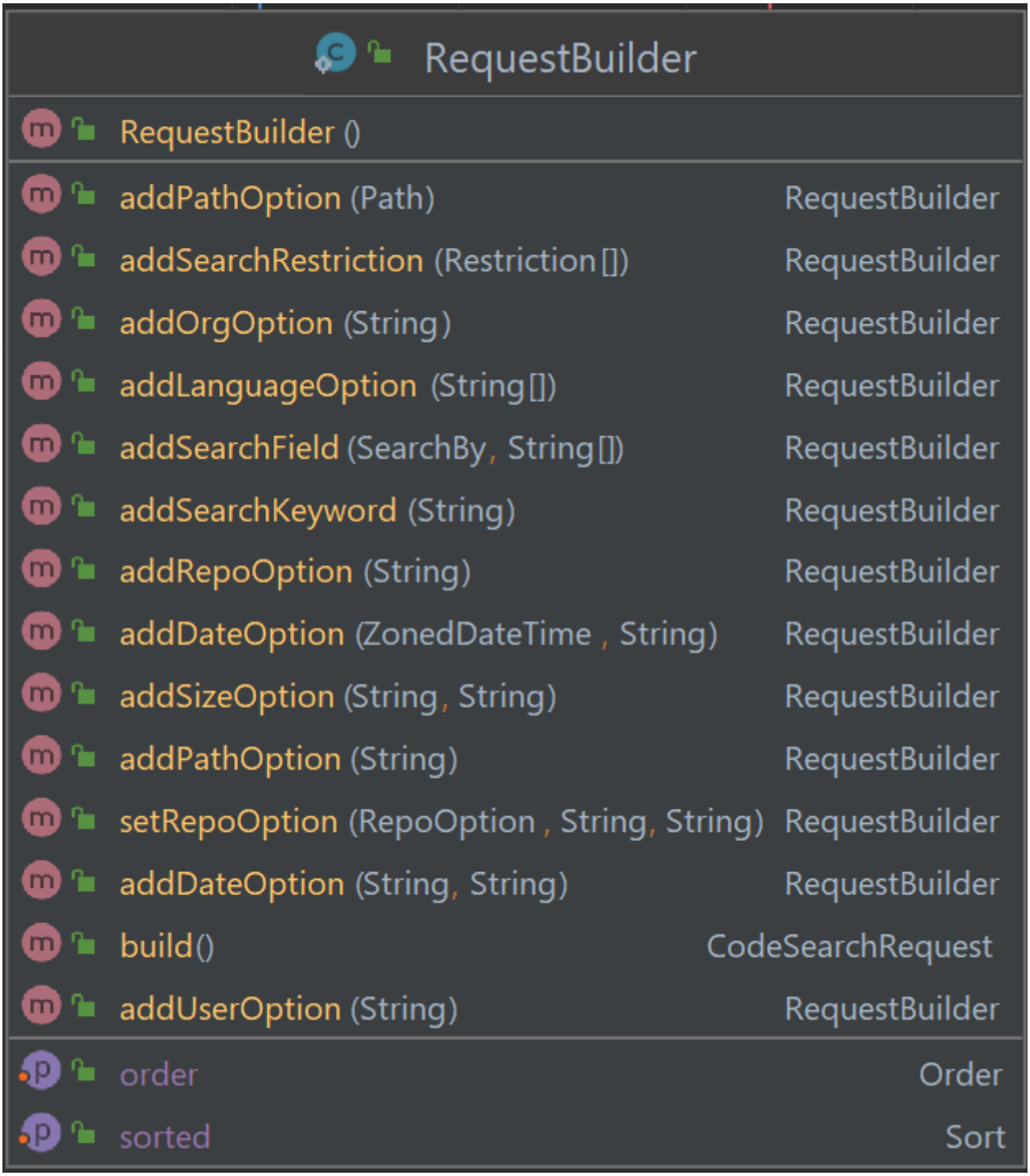
Basic Usage (A demonstration)

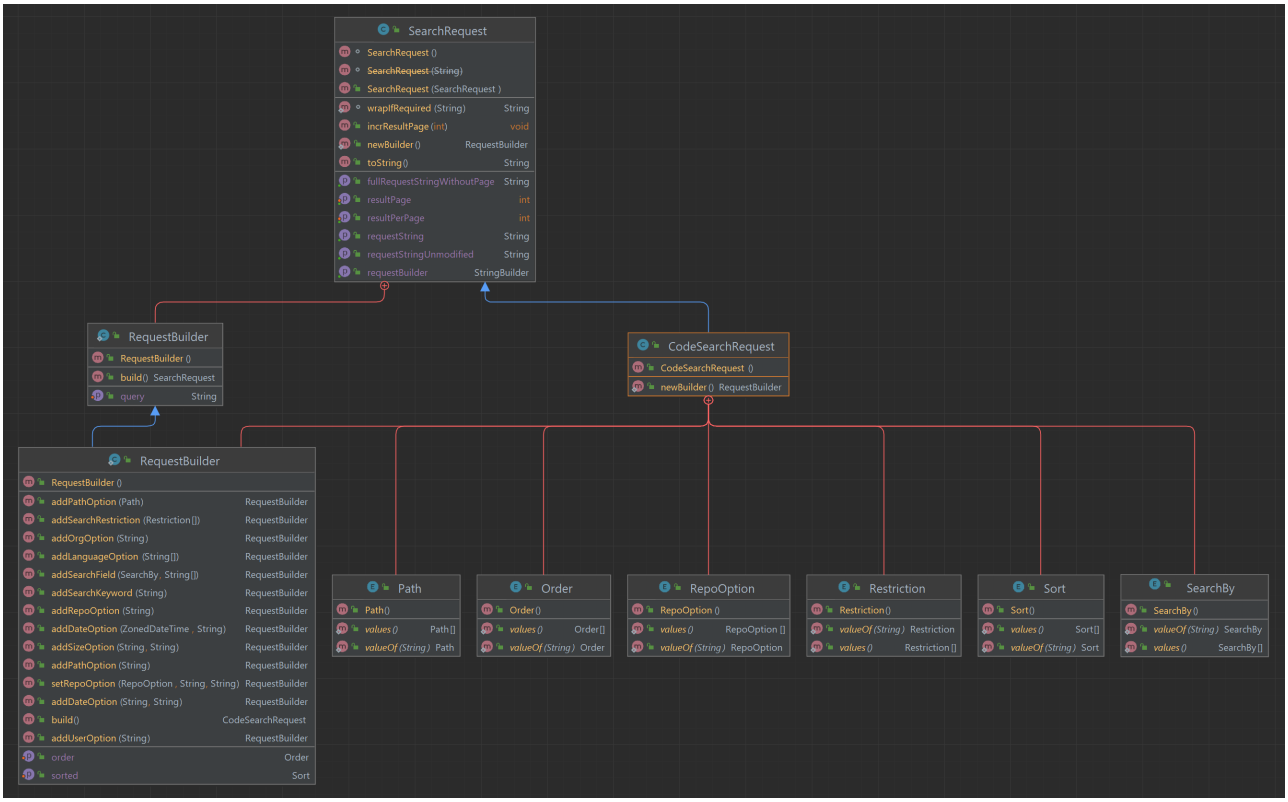
Build a request

```
    CodeSearchRequest req1 = CodeSearchRequest.newBuilder()
        .addSearchField(CodeSearchRequest.SearchBy.Filename,
"pom.xml")
        .addLanguageOption("Maven POM")
        .build();
```

Similar searches can be done on `Issues`, `Pull Requests`, `Commits`, `Users`, `Repositories`, `RawFiles`.

A detailed list on how to construct queries are listed below (the example only contains the method in `CodeSearchRequest.RequestBuilder()`)


RequestBuilder
RequestBuilder ()
addPathOption (Path) RequestBuilder
addSearchRestriction (Restriction[]) RequestBuilder
addOrgOption (String) RequestBuilder
addLanguageOption (String[]) RequestBuilder
addSearchField (SearchBy, String[]) RequestBuilder
addSearchKeyword (String) RequestBuilder
addRepoOption (String) RequestBuilder
addDateOption (ZonedDateTime, String) RequestBuilder
addSizeOption (String, String) RequestBuilder
addPathOption (String) RequestBuilder
setRepoOption (RepoOption, String, String) RequestBuilder
addDateOption (String, String) RequestBuilder
build() CodeSearchRequest
addUserOption (String) RequestBuilder
order Order
sorted Sort



Similarly will we have `RepoSearchRequest`, `IPRSearchRequest`, `UserSearchRequest`, etc.

Note that for ***all*** SearchRequests, the methods of them have been ***fully implemented***.

Example Usage

Search in GitHub

```
    //Register the API
    private final GitHubAPI gitHubAPI =
GitHubAPI.registerAPI(PersonalAccessToken);

    CodeSearchRequest req1 = CodeSearchRequest.newBuilder()
            .addSearchKeyword("dependency")
            .addSearchField(CodeSearchRequest.SearchBy.Filename,
"pom.xml")
            .addLanguageOption("Maven POM")
            .build();

    CodeResult result1 = gitHubAPI.searchAPI.searchCode(req1,
                                                        count,

LOCAL_SEARCH_UPDATE_INTERVAL_MILLIS);
```

Query the results

```
    for(CodeItem item: result1){

        Repository repo = item.getRepository();
        System.out.println(repo.getFullName() + ", " +
item.getName());

        //Get the list of contributors
        List<User> userList =
gitHubAPI.repositoryAPI.getContributors(repo);

        //Sort users by their contributions in the specific
repository

userList.sort(Comparator.comparingInt(User::getContributions).rever
sed());
        for(User user: userList){
            System.out.println(user.getLogin());
        }
    }
```

Abstractions

All items related to the **search** part of the GitHub RestAPI has been implemented. See the file tree above to get more info.

These objects provides a basic but complex abstraction of entities on the GitHub website. At the same time, all the objects are POJOs and can be easily serialized and deserialized.

Implementation of the GitHub Search Engine (Partially)

See the source code.

Documentations

Documentations will later be generated in the format of JavaDoc directly from those JavaDoc embedded in the code. The code implements the basic methods all as generic, and users are expected to check the documents of those generic methods when encountering specific problems with the implementation of a specifc method (that is related to a certain abstraction, for example `User`).

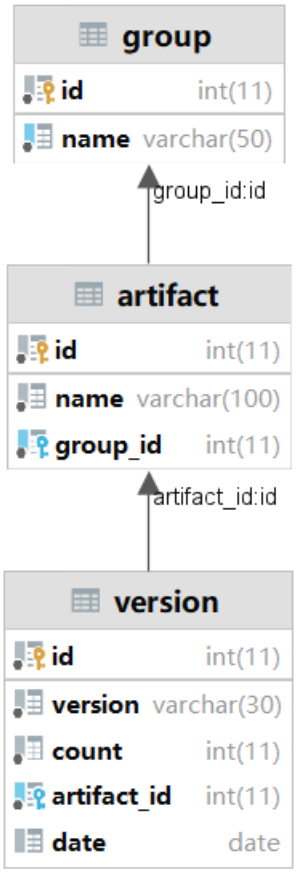
Data Persistence

We use two methods for data persistence:

Database

We use cloud **MySQL** database and **Mybatis** ORM framework

.



Here is an dto example

```
@Data
@AllArgsConstructor
@NoArgsConstructor
@Repository
public class Version {
    Integer id;
    String version;
    Integer count;
    Integer artifactId;
}
```

Here is an dao example, we use **Mybatis**

```
public interface VersionDao {
    int insert(@Param("version") String
version,@Param("artifactId") Integer artifactId);

    Version get(@Param("version") String
version,@Param("artifactId") Integer artifactId);

    //count++
    void increment(@Param("id") Integer id,@Param("newCount")
Integer newCount);
}
```

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE mapper PUBLIC "-//mybatis.org//DTD Mapper 3.0//EN"
"http://mybatis.org/dtd/mybatis-3-mapper.dtd">
<mapper namespace="edu.sustech.backend.dao.VersionDao">
    <insert id="insert">
        insert into version(version, count, artifact_id) values (#
{version},1,#{artifactId})
    </insert>

    <select id="get" resultType="Version">
        select * from version where version=#{version} and
artifact_id=#{artifactId}
    </select>

    <update id="increment">
```

```
        update version set count=#{newCount} where id=#{id}
    </update>
</mapper>
```

File

Besides the database, we also use files, which stores the json data of the repo dependency information.

Dependency Analysis Insights

`Log4j` and `JUnit` has been the most dependencies along repositories sampled. We found that dependencies that are related to loggings and tests are widely used in the sampled repositories.

`Lombok` are used most frequently in China, `Spring` are adopted more frequently in the United States, and `MySql` are used quite frequently in China.

Along the sampled repositories, it seemed that developers in China prefer to use more tools related to the editing, verifying and building process of the whole lifecycle in Maven-based projects, whereas developers in the United States seems to be developing small network servers, or micro-services more (which indirectly results in the trending usage of `Spring` and its related transitive dependencies, along with other dependencies that provides a more frequently used result).

We found that developers are more concentrated in the European region, and that developers in China have contributed more that many western countries. People in South America has also contributed a lot, but the numbers are relatively much lower when compared to developers in China.

We found that the GitHub Rest API frequently occur secondary-rate-limitations, which is not good for web-scraping and data collection and analysis. Thus, we have only about 1000 sampled data.